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RESEARCH ARTICLE

Compliance to COVID-19 Safety Guidelines during Practical Class: An Investigative Study of the Engineering Students in IMO State Polytechnic

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ABSTRACT: The World Health Organization stipulated safety guidelines to curb the spread of Covid-19. In this study, the influence of workshop temperature, duration of practical class and week of study on compliance to nose masking and hand washing by engineering students of Imo State Polytechnic Umuagwo during practical were evaluated. Firstly, the knowledge, attitude and practice (KAP) of the students were obtained using a well-structured questionnaire and analyzed using the Likert 5-point rule, while the significant means differences were determined using Tukey's method at a 5% probability level. Secondly, a 17-unit experiment designed in Box-Behnken with Design-Expert software version 11.0 was used to study the interactions of each numeric factor varied at 3 levels and regression models that captured 99.16% (R^2 = 0.9916) and 98.17% (R^2 = 0.9817) variations in the prediction of the number of nose masks and volume of water for hand washing, respectively were generated. Three levels each of workshop temperatures (23 – 25, 26- 28, and 29 - 31°C), practical duration (0 -20, 21-40, and 41-60 minutes), and week of study of school resumption (3, 4, and 5) were considered. The results show that 68.88%, 71.38% and 60.63% of the students have 'good' KAP toward Covid-19between weeks 3 and 4, the use of nose masks dropped by 64.20% where as the volume of water increased by 28.06%. Between weeks 4 and 5, nose masking dropped by 63.22% whereas the volume of water for hand washing rose by 15.95%. Nose masking reduced with increased workshop temperature and week of study whereas hand washing increased with workshop temperature. The outcome of this study will aid in the development of prediction models for transmittable diseases and would help formulate policies and guidelines for health regulatory agencies. Recommendations for further studies were stated.

KEYWORDS: Covid-19, knowledge, attitude and practice, engineering students, practical class, Nigeria.

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INTRODUCTION

The World Health Organization (WHO), in December 2019 announced an outbreak of coronavirus disease (COVID-19) caused by a new strain of coronavirus (SARS-CoV-2) in Wuhan, China [1]. It was declared a global pandemic on the 11th of March 2020[2]. A year after there were above 117,161,735 reported confirmed cases; 66,375,685 recoveries and 2,600,564 deaths globally [3]. In February 2020, the Nigerian Centre for Disease Control [4] reported an index case of Covid-19, but by March 11, 2021,the number of confirmed cases rose above 159,465, with 139,104 recoveries and 1,990 death [5].

Ejeh et al., [6] defined coronavirus (CoV) as envelope, single-stranded RNA viruses that are responsible for -like symptoms characterized by severe acute respiratory symptoms, high morbidity and mortality. According to Afemikhe *et al.*[7], persons infected with Covid-19 come down with fever, cough, fatigue, muscle pain, sore throat, loss of smell, and abdominal discomfort. Severe cases of the virus are present symptoms of acute respiratory distress syndrome, progressive pneumonia, sepsis, organ failure, and septic shock, which often lead

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to death [8]. Transmission from person to person is by direct contact with droplets of the infected during sneezing, coughing or talking on any surface.

The initial approach to combating the Covid-19 pandemic was mainly limiting the spread and transmission by adopting safety guidelines stipulated by WHO, as well as other local health agencies in different countries. The guidelines are frequent washing of hands under runny water with soap or about 70% alcohol-based sanitizer, coughing, sneezing and yawning atthe elbow, keeping about a two-meter physical distance, wearing nose masks, limiting long-distance travelling, avoiding frequent touching of the face and temporary closure of schools. In compliance with the global lockdown, the Nigerian Government enforced a total lockdown in the country on20th March2020, which lasted for six months thereafter; there was gradual ease of lock down. As a result, academic activities in higher institutions in Nigeria which are provided in the Universities, Polytechnics, Colleges of Technology and Colleges of Education, were grounded. On resumption of school, students returning to school were under strict instruction to observe the WHO guidelines to curtail the spread of Covid-19. However, the level of compliance with these guidelines is not adequately monitored especially during practical classes; hence there is no record of compliance with the covid-19 guideline by students during practical classes. Singh *et al.* [9] and Ifijeh and Yusuf [10] suggested online study by university students to minimize physical contact and limit transmission. But engineering practical classes require operations of heavy machines situated in-school workshops; consequently, physical contact with infected persons and surfaces is possible which might likely increase the spread of Covid-19 among engineering students in tertiary institutions.

This present study was conducted during the dry season therefore; the findings of this present study may not apply to the rainy season which is generally characterized by rainfall intensity, low solar radiation, and ambient humidity. The psychological aspect of the students' KAP was not considered. Hatabu*et al.*[1] concentrated on the psychological aspects of students in their KAP study. It reported that introverts and female genders have more adherence to safety guidelines than extroverts and male genders. However, there is a dearth of information on compliance with guidelines for Covid-19 by tertiary students during practical classes. The factors considered namely workshop temperature, duration of practice classes and week of study are measurable and related to practical conditions. This study, therefore, focuses on the level of knowledge, attitude and practice (KAP) to Covid-19amongengineeringstudentsofImo State Polytechnic, and examines compliance with nose masking and hand washing guidelines in curbing Covid-19spread during practical sessions. The specific objectives of this study are to determine which of the two is more complied with as well as recommend optimal conditions to enhance compliance to curtail the spread of Covid-19 in institutions of higher learning.

MATERIALS AND METHODS

The Study Area

Imo State is one of the 36 states of Nigeria in the Southeast region with Owerri as the capital. The land area is 5,530km^{2}with a population of about 4,978758 people. It lies within latitudes 4^{o}45^{1}N and 7^{o}15^{1}N and longitude 6^{o}50^{1}E and 7^{o}25^{1}E. The State hosts about seven high institutions owned by both government and private sectors.

Imo State Polytechnic Umuagwo is one of the State-owned institutions located in the Ohaji-Egbema Local Government Area. It lies between latitude 5^o 18' 12.60''N and longitude 6^o 56' 26.39''E and an altitude of 52m.There are two major climatic seasons predominant in the area: the dry season (November to March) and the rainy season (April to October) with a reduced rainfall intensity (August break) in August. The average annual rainfall and temperature are 2050mm and 32^{o}C, respectively. This study was conducted for a period of 5 weeks (February 1 to March 5, 2021) during the first semester.

The institution runs two semesters system in one academic year. A semester spans18 to 20 weeks like most universities in Nigeria [11].Students are admitted into Departments such as Agricultural and Bioenvironmental Engineering, Chemical Engineering, Mechanical Engineering, Electrical/Electronic Engineering, and Civil Engineering for a two-year National Diploma (ND) and Higher National Diploma (HND) certificate courses. A minimum of two practical classes are held three days per week at different Departmental laboratories/workshops for one hour and the students are expected to keep to the safety guidelines stipulated by WHO/NCDC during practical classes.

Sampling and Data Collection

The study population is the undergraduate students of Imo State Polytechnic Umuagwo. However, the engineering students of the institution were selected as the study sample. Two sources of data collection were adopted to achieve the two objectives of the study:

The entire field survey was offline-based where data were collated with ease from and within the ambient of the study area. The first data source was a well-structured questionnaire aimed at achieving the first objective. The questionnaire was adapted to the knowledge, attitude and perception (KAP) survey methodology toCOVID-19. Similar questionnaire templates were used to understudy undergraduate students KAP to Covid-19 in China [12] (Wu and Munthali, 2021), Japan [1]and India [9]and during the Ebola outbreak in Nigeria[13].For this study, the questionnaire was divided into four sections: section "A" was used to assess the socio-demographic characteristics of the students, section "B"(5 questions) assessed their levels of KnowledgeaboutCovid-19, and section "C" (5questions) evaluated levels of attitude, whereas section "D" (6 questions) captured the levels of compliance to prevention guidelines stipulated by WHO during studies but in this case practical classes.

The second data source was for the second objective. The data collection for nose masking was physical counting of the number of students that wore nose masks during practical classes. Whereas the volume of hand sanitizer used for hand washing was obtained by volume differences of hand sanitizer placed in calibrated water containers at strategic corners meant for periodic hand washing during practical classes. The test-retest reliability approach was adopted to determine the questionnaire's reliability. This method entails surveying a set of respondents, repeating it with the same group at a later time, and comparing the results.

Experimental Design and Data Analysis

The first objective of the study was achieved by analyses of sections "A" to "D" of the questionnaire. The socio-demographic characteristics (Section "A") of the students were analyzed using frequencies and percentages. For ease of analysis, correct answers to questions in sections "B" and "C" of the questionnaire were assigned 3 marks each, whereas unsure and wrong answers carried 2 and 1 mark respectively; hence a total score of 15marks for each section of "B" and "C". From the students' responses, the levels of knowledge and attitude toward COVID-19 were summed up and categorized into "poor", "average" and "good" for scores ranging from 1-5, 6-10 and 11-15 points, respectively. For section "D", the Likert5-point rule was adopted to assess levels of practice to guidelines on Covid-19 prevention. Likert 5-point rules assign 5points to strongly agree, 4points, unsure 3, disagree 2 and strongly disagree 1 point. Based on the correctness of the answers, the Likert rule was applied. Scores from 0-10, 11-20 and 21-30 points are categorized as "poor", "average" and "good" respectively. The significant means differences of the sections were determined using Tukey's method at 5% probability levels using online statistical software [14].

Design Expert 6.06 version statistical software was used to design an experiment using the Box-Behnken (BB) design in Response Surface Methodology (RSM) to achieve the second objective. The experiment involved the evaluation of the effects of workshop temperature, duration of practical class and week of study on nose masking and hand washing hygiene of the engineering students during their one-hour practical classes. Engineering students hold their one-hour practical every Monday, Wednesday and Friday morning at three workshops situated in one building either from 8:00 amto9:00 am or 9:00 am to 10:00am. The dimensions of the workshops are 60x 30 x 25feetin length, width and height with an average of thirty-five students per practical class. Box-Behnken (BB) factorial design was used to design an experiment of three factors on three levels with two response variables to undertake the study. The three factors and their levels are coded as shown in Table 1. From Table 1, 0 -20 minutes, 21-40 minutes and 41-60 minutes represent the three levels of the duration of the practical class. The workshop temperatures were also grouped into three namely 23 – 25^{o}C, 26- 28^{o}C and 29 to 31^{o}C, these ranges represent the three levels of workshop temperature. The average room temperature of the workshops was obtained using digital thermometers whereas the average hourly ambient temperature on days of the practical classes was obtained from the institution's Metrologic unit. Weeks of the study were weeks 3 to 5 of school resumption, representing three levels. Meanwhile, the first two weeks of school resumption were used to

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administer and collate the questionnaires. For each 20minutes time interval of practical class, the average number of students wearing nose-mask and the volume differences of the sanitizer in the containers were determined after four observations. Seventeen (17) experimental units (Table 2) were used to analyse the interaction effect and optimize the responses. The factors levels (independent variables) and the coding for each of the 17 experimental units as well as the two observations/responses (dependent variables) which are the average number of students wearing nose masks and the volume of sanitizer used for hand washing across the interactions are shown in Table 2.

Table 1: Box-Behnken fractional factorial designs showing the three factors, levels and codes

Factors	Symbol Coded	Levels		
		-1	0	+1
Temp (°C)	A	23 – 25	26- 28	29– 31
Time (mins.)	B	0 -20	21-40	41-60
Weeks	C	3	4	5

Table 2: Box Behnken design of three factors in coded and actual factor levels

Runs	Coded Factor A: Temp (°C)	Coded Factor B:Practical duration (mins)	Factor C: No. of weeks	Actual Factor A: temp (°C)	Actual Factor B:Practical duration (mins)	Actual Factor C: No. of weeks
1	-1.000	-1.000	0.000	25.00	20.00	4.00
2	1.000	-1.000	0.000	31.00	20.00	4.00
3	-1.000	1.000	0.000	25.00	60.00	4.00
4	1.000	1.000	0.000	31.00	60.00	4.00
5	-1.000	0.000	-1.000	25.00	40.00	3.00
6	1.000	0.000	-1.000	31.00	40.00	3.00
7	-1.000	0.000	1.000	25.00	40.00	5.00
8	1.000	0.000	1.000	31.00	40.00	5.00
9	0.000	-1.000	-1.000	28.00	20.00	3.00
10	0.000	1.000	-1.000	28.00	60.00	3.00
11	0.000	-1.000	1.000	28.00	20.00	5.00
12	0.000	1.000	1.000	28.00	60.00	5.00
13	0.000	0.000	0.000	28.00	40.00	4.00
14	0.000	0.000	0.000	28.00	40.00	4.00
15	0.000	0.000	0.000	28.00	40.00	4.00
16	0.000	0.000	0.000	28.00	40.00	4.00
17	0.000	0.000	0.000	28.00	40.00	4.00

Design considerations

The following variables were considered:

i. The three temperature groups (23-25, 26-28, and 29-31°C) were adopted because of the range of average workshop temperatures (24-30°C) determined with a digital thermometer on the days of practical classes. The average hourly ambient temperatures were between 26 and 29^{o}C that of the city was 28^{o}C.

ii. Also, the first five weeks of school resumption were adopted for the study because of the usual strict enforcement of safety guidelines by the school authorities at the resumption of the academic session. More so, Ajilore *et al.*[13] reported high compliance to safety guidelines by students during the early outbreak of Ebola, and a similar report of high compliance to WHO rules during the Covid-19 pandemic by students in Japan[1]. The first two weeks were used for administering and collating questionnaires, whereas the other three weeks were used to test compliance with the safety guidelines.

iii. The physiological and emotional conditions of the students were not considered factors in the experiment. Hatabu *et al.*[1] posited these factors influence adherence to guidelines.

RESULTS

Knowledge, Attitude and Practice Levels of Students

The results of the socio-demographic characteristics of the 800 students in the survey are presented in Table 3.It shows that the highest percentage of the students 60.17% (482) were within 21-30 years, and only about 9.86% (79) were above 30years. There were more male (71.91%) students than female (26.84%), 698 (87.14%) are single and 578 (72.16%) live off-campus.

Table 3: Socio-demographic characteristics of the students

Variable	Categories	Frequency	Per cent
Ages	<20	240	29.96
	21-30	482	60.17
	>30	79	9.86
Sex	Male	576	71.91
	Female	225	26.84
Year of Study	First	194	24.25
	Second	108	13.50
	Third	201	25.13
	Fourth	297	37.13
Department	Agricultural Engineering	75	9.36
	Mechanical Engineering	184	22.97
	Chemical Engineering	193	24.09
	Civil Engineering	122	15.23
	Electrical/ electronic	227	28.35
Statues	Single	698	87.14
	Married	103	12.86
Programmes of study	HND	499	62.30
	ND	302	37.70
Residence	On-campus	123	15.36
	Off-campus	678	84.64
Religion	Islam	13	1.62
	Christianity	767	95.76
	Others/none	21	2.62

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Table 4 presents the overview responses of 'Yes', 'No' and 'Unsure' to the five questions on the knowledge about Covid-19 transmission and prevention. Test of significant mean difference shows that means (M_1) of 'Yes' responses are significantly different from the mean (M_2) of 'No' and mean (M_3) of 'Unsure' responses respectively whereas the difference between 'No' and 'Unsure' means are not significantly different.

The result of the levels of knowledge of Covid-19 prevention and transmission among the students as categorized into 'Good', 'Average' and 'Poor' presented in Table 5 below shows that 68.88% of the engineering students have good knowledge, whereas 31.50% and 5.13% have an average and poor level of knowledge respectively.

Table 4: Knowledge about Covid-19 transmission and prevention (n = 800)

Knowledge of Covid-19	**YES**	**NO**	**Not sure**	**Tukey's method of Mean Differences**
Covid-19 is an infectious disease that affects the respiratory system	711(88.88%)	24(3%)	65 (8.13%)	M1 vs M2 significant (P <0.01) M_1 vs M_3 significant M_2 vs M_3 not significant (P <0.01)
Symptoms of Covid-19 include sore throat, dry cough, fever, running nose, difficulty in breathing	794(99.25%)	3(0.38%)	3 (0.38%)	
COVID-19 is spread by contact with droplets from the cough or sneeze of an infected person, or contact with contaminated surfaces	725(90.63%)	46(5.75%)	29(3.62%)	
The incubation period for COVID-19 symptoms to manifest is 1-14days	722 (90.25%)	1(0.13%)	77(9.62%)	
The people likely to die when infected with COVID-19 are:				
Elderly	701(87.63%)	3(0.38%)	96(12%)	
Youths	84(10.5%)	663(83%)	53(6.63)	
Children	67(8.38%)	681(85.12%)	52(6.5%)	
People with underlying infections	786(98.25)	5(0.63%)	13(1.63%)	
Health care workers	563(70.38%)	133(16.63%)	104 (13%)	
Mean	572.56	173.22	54.67	

M_1, M_2, and M_3 signify Yes, No and Not sure responses, respectively

From Table 6, the differences between the mean (M_1) of 'Yes' responses and the mean (M_2) of 'No' responses are significant at a 5% probability level but not with a mean (M_3) of 'Unsure' responses. Also means M_2 and M_3 of 'No' and 'Unsure' responses are significantly different. The level of attitude toward covid-19 transmission and prevention among the students shown in Table 7 indicates that despite a good level of knowledge of the covid-19 mode of transmission and prevention, 71.38% have 'good attitude, whereas 19.25% and 9.38% have 'Average' and 'Good' attitude.

Table 5: Level of Knowledge of Covid -19 transmission and prevention among Engineering students (n=800)

Variable	**Category**	**Frequency**	**Level of Knowledge**			**P-value**
			Poor (%)	**Average (%)**	**Good (%)**	
Ages	<20	240	13 (5.42)	109 (45.42)	118 (49.17)	0.1934
	21-30	482	19 (3.94)	131 (27.18)	332 (68.88)	
	>30	78	9 (11.54)	12 (15.38)	57 (73.08)	
	Total	800	41(5.13)	252(31.50)	507(63.3)	
Sex	Male	576	23 (3.99)	150 (26.04)	403(69.97)	0.30915
	Female	224	18 (8.04)	102(45.54)	104 (46.43)	
	Total	800	41(5.13)	252(31.50)	507(63.3)	
Year of Study	First	194	6 (3.09)	56 (28.87)	132(67.04)	0.0015*
	Second	108	4 (3.70)	32 (29.60)	73(67.50)	
	Third	201	14(6.97)	67(33.33)	120(59.70)	
	Fourth	297	17(5.72)	97(32.66)	182(61.28)	
	Total	800	41(5.13)	252(31.50)	507(63.3)	
Department	Agricultural Engineering	75	4(5.33)	16(21.33)	55(73.33)	0.0007*
	Mechanical Engineering	184	13(7.07)	50(27.17)	138(65.76)	
	Chemical Engineering	193	10(5.18)	45(23.32)	143(71.50)	
	Civil Engineering	121	9(7.44)	37(30.58)	75(61.98)	
	Electrical/ electronic	227	5(2.22)	104(45.25)	118(51.98)	
	Total	800	41(5.13)	252(31.50)	507(63.3)	
Statues	Single	698	34(4.87)	231(33.09)	433(62.03)	0.4818
	Married	102	7(6.86)	21(20.59)	74(72.55)	
	Total	800	41(5.13)	252(31.50)	507(63.3)	
Programmes of study	HND	498	32(6.43)	167(33.53)	299(60.04)	0.0441*
	ND	302	9(2.98)	85(28.15)	208(68.87)	
	Total	800	41(5.13)	252(31.50)	507(63.3)	
Residence	On-campus	122	18(14.75)	27(22.13)	77(63.11)	0.4656
	Off-campus	678	23(3.39)	225(33.19)	430(63.42)	
	Total	800	41(5.13)	252(31.50)	507(63.3)	
Religion	Islam	103	8(7.77)	24(23.30)	71(68.93)	0.4843
	Christianity	676	25(3.70)	221(32.69)	430(63.61)	
	Others/none	21	8(38.10)	7(33.33)	6(28.57)	
	Total	800	41(5.13)	252(31.50)	507(63.3)	

Table 6: Attitude towards Covid-19 Transmission and Prevention (n = 800)

The consciousness of Covid-19 makes me	**Yes**	**No**	**Not sure**	**Tukey's test of Mean differences HSD [0.05] =93.16; HSD [0.01] =124.57**
Afraid, I could die if infected	78 (9.75%)	531 (66.38%)	191 (23.88%)	M_1 vs M_2 significant(P <0.01)
Slightly insecure, when with others	98 (12.25%)	651(81.38%)	51 (6.38%)	M_1 vs $M_3$is not significant
Anxious to go for testing	32 (4%)	572 (71.5%)	196 (24.5%)	
Believe the end time has come	43 (5.38%)	566 (70.75%)	191 (23.88%)	M_2 vs M_3 significant (P <0.01)
Worried, I could be infected	139 (17.38%)	492 (61.5%)	169 (21.13%)	
Mean	278.8	449.2	662.8	

M_1, M_2, and M_3signifyYes, No and Not Sure responses, respectively.

Table 7: Level of attitude to transmission and prevention of Covid-19

Variables	**Categories**	**Frequency**	**Level of Attitude**			
			Poor (%)	**Average (%)**	**Good (%)**	**P-value**
Ages	<20	240	17(7.08)	43(17.92)	180 (75.00)	0.1229
	21-30	482	46(9.54)	94(19.50)	342 (70.95)	
	>30	78	12(15.38)	17(21.79)	49 (62.82)	
	Total	800	75(9.38)	154(19.25)	571(71.38)	
Sex	Male	576	44(7.64)	123(21.35)	409(71.01)	0.1886
	Female	224	31(13.84)	31(13.84)	162(72.32)	
	Total	800	75(9.38)	154(19.25)	571(71.38)	
Year of Study	First	194	45(23.20)	15(7.73)	134(69.07)	0.0052*
	Second	108	16(14.81)	35(32.41)	57(52.78)	
	Third	201	6(2.99)	30(14.93)	165(82.09)	
	Fourth	297	8(2.69)	74(24.92)	215(72.39)	
	Total	800	75(9.38)	154(19.25)	571(71.38)	
Department	Agricultural Engineering	75	3(4.00)	5(6.67)	67(89.33)	0.0004*
	Mechanical Engineering	184	56(30.43)	32(17.39)	96(52.17)	
	Chemical Engineering	193	6(3.11)	56(29.02)	131(67.88)	
	Civil Engineering	121	6(4.96)	13(10.74)	102(84.30)	
	Electrical/ electronic	227	4(1.76)	48(21.15)	175(77.09)	
	Total	800	75(9.38)	154(19.25)	571(71.38)	
Statues	Single	698	67(9.60)	87(12.46)	544(77.94)	0.5316
	Married	102	8(7.84)	67(65.69)	927 (26.47)	
	Total	800	75(9.38)	154(19.25)	571(71.38)	

Programmes of study	HND	498	43(8.63)	127(25.50)	328(65.86)	0.03589*
	ND	302	32(10.60)	27(8.94)	243(80.46)	
	Total	800	75(9.38)	154(19.25)	571(71.38)	
Residence	On-campus	122	36(29.51)	24(19.67)	62(50.82)	0.4621
	Off-campus	678	39(5.75)	130(19.17)	509(75.07)	
	Total	800	75(9.38)	154(19.25)	571(71.38)	
Religion	Islam	103	43(41.75)	24(23.30)	36(34.95)	0.4993
	Christianity	676	24(3.55)	122(18.05)	530(78.40)	
	Others/none	21	8(38.10)	8(38.10)	5(23.81)	
	Total	800	75(9.38)	154(19.25)	571(71.38)	

The overview of the student's responses to practice toward Covid-19 transmission and prevention is shown in Table 8 below. These practices are the stipulated guidelines by the WHO and NCDC on the prevention of the spread of Covid-19. From Table 8, the mean (M_1) of the 'Yes' response is not significantly different from the mean (M_2) of 'No' and mean (M_3) of 'Unsure' respectively whereas the mean (M_2) of 'No' responses are significantly different from mean (M_3) of 'Unsure'.

Table 8: Practice towards Covid-19 Transmission and Prevention (n = 800)

Covid-19 can be prevented by:	**Yes**	**No**	**Not sure**	**Tukey's test of mean differences (HSD [0.05] =366.18, HSD [0.01] =489.63)**
Social distancing	203 (25.38%)	543 (67.88%)	54(6.75%)	M_1 vs $M_2$is not significant
Wearing nose mask	658 (82.25%)	131 (16.38%)	11(1.38%)	M_1 vs $M_3$is not significant
Regular hand washing	469 (58.63%)	258 (32.25%)	73(9.13%)	M_2 vs $M_3$is significant ($P<0.05$)
Vaccination	7 (0.88%)	745 (93.13%)	48 (6%)	
Stay home	122 (15.25%)	664 (83%)	17 (2.13)	
Mean	291.80	408.20	40.60	

The level of the students' compliance or practice with the stipulated guidelines elicited from their responses for curbing transmission of covid-19 is shown in Table 9. About60.63% of the students have 'Good' practice in the prevention of Covid-19 whereas 33.38% and 6% have 'Average' and 'Poor' practices.

Table 9: Level of practice to covid-19 transmission and Prevention (n=800)

Variables	**Categories**	**Freq.**	**Level of practice**			**P-value**
			Poor (%)	**Average (%)**	**Good (%)**	
Ages	<20	240	9(3.75)	67(27.92)	164(68.33)	0.4954
	21-30	482	23(4.77)	183(37.97)	276(57.26)	
	>30	78	16(20.51)	17(21.79)	45(57.69)	
	Total	800	48(6)	267(33.38)	485(60.63)	
Sex	Male	576	28(4.86)	164(28.47)	384(66.67)	0.3197
	Female	224	20(8.93)	103(45.98)	101(45.09)	
	Total	800	48(6)	267(33.38)	485(60.63)	

Year of Study	First	194	4(2.06)	52(26.80)	138(71.13)	0.0026*
	Second	108	2(1.85)	46(42.59)	60(55.56)	
	Third	201	18(8.96)	63(31.34)	120(59.70)	
	Fourth	297	24(8.08)	106(35.69)	167(56.23)	
	Total	800	48(6)	267(33.38)	485(60.63)	
Departments	Agricultural Engineering	75	9(12.00)	16(21.33)	50(66.67)	0.0025*
	Mechanical Engineering	184	16(8.70)	46(25.00)	122(66.30)	
	Chemical Engineering	193	8(4.15)	45(23.32)	140(72.54)	
	Civil Engineering	121	6(4.96)	41(33.88)	74(61.16)	
	Electrical/ electronic	227	9(3.96)	119(52.42)	99(43.61)	
	Total	800	48(6)	267(33.38)	485(60.63)	
Statues	Single	698	34(4.87)	244(34.96)	420(60.17)	0.5208
	Married	102	14(13.73)	23(22.55)	65(63.73)	
	Total	800	48(6)	267(33.38)	485(60.63)	
Programmes of study	HND	498	40(8.03)	163(32.73)	295(59.24)	0.0523
	ND	302	8(2.65)	104(34.44)	190(62.91)	
	Total	800	48(6)	267(33.38)	485(60.63)	
Residence	On-campus	122	18(14.75)	31(25.41)	73(59.84)	0.4905
	Off-campus	678	30(4.42)	236(34.81)	412(60.77)	
	Total	800	48(6)	267(33.38)	485(60.63)	
Religion	Islam	103	3(2.91)	24(23.30)	76(73.79)	0.4954
	Christianity	676	39(5.77)	239(35.36)	398(58.88)	
	Others/none	21	6(28.57)	4(19.05)	11(52.38)	
	Total	800	48(6)	267(33.38)	485(60.63)	

Nose Masking

Having obtained the results of the KAP levels of the engineering students in the first two weeks of return to school, the result of the second part of the study which examined the impact of weeks of study, duration of the practical class and the laboratory/workshop room temperature on the wearing of nose masks and hand washing hygiene are shown in Table 10 containing the actual (experimental) and predicted responses.

Table 10: Result of the number of students wearing nose masks and the volume of water used for hand washing during practical classes of engineering students at Imo State Polytechnic

No. of runs	Temp(°C)	Practical duration (mins)	No. of weeks	No. of students with mask		Volume of water used	
				Actual	Predicted	Actual	Predicted
1	28.00	20.00	3.00	223	207.37	23	24.12
2	38.00	20.00	3.00	112	103.37	55	58.12
3	28.00	60.00	3.00	104	112.62	45	41.88

4	38.00	60.00	3.00	79	94.62	70	68.87
5	28.00	40.00	1.00	443	444.13	44	47.12
6	38.00	40.00	1.00	300	294.13	65	66.12
7	28.00	40.00	5.00	135	140.88	43	41.87
8	38.00	40.00	5.00	170	168.88	87	83.87
9	33.00	20.00	1.00	325	339.50	76	71.75
10	33.00	60.00	1.00	288	278.25	75	75.00
11	33.00	20.00	5.00	106	115.75	67	67.00
12	33.00	60.00	5.00	88	73.500	88	92.25
13	33.00	40.00	3.00	154	154.00	66	66.00
14	33.00	40.00	3.00	154	154.00	66	66.00
15	33.00	40.00	3.00	154	154.00	66	66.00
16	33.00	40.00	3.00	154	154.00	66	66.00
17	33.00	40.00	3.00	154	154.00	66	66.00

The analyses of the relationships between the variables and the actual experimental responses (number of nose masks, N_m) were defined with a regression model equation (Eq. 1).

$$N_m = 154 - 30.50A - 25.87B - 107.13C + 17.87A^2 - 42.38B^2 + 90.13C^2 + 21.50AB$$
$$+44.50AC \; (R^2 = 0.9916)(1)$$

The regression equation in Eq. (1) was used to predict the values of the number of nose masks shown in Table 10. Table 11shows the analysis of the variance of the model terms, and test of significant differences of the linear, product and interactions model terms for the number of students that wore nose masks.

Table 11: Analysis of variance of regression model for those wearing nose mask

Source	Sum of Squares	DF	Mean Square	F Value	Prob > F	Definition
Model	156428.5	9	17380.95	92.22408	< 0.0001	significant
A	7442	1	7442	39.48759	0.0004	significant
B	5356.125	1	5356.125	28.41984	0.0011	significant
C	91806.13	1	91806.13	487.1274	< 0.0001	significant
A2	1345.329	1	1345.329	7.138376	0.0319	significant
B2	7560.592	1	7560.592	40.11684	0.0004	significant
C2	34200.07	1	34200.07	181.4671	< 0.0001	significant
AB	1849	1	1849	9.810877	0.0166	significant
AC	7921	1	7921	42.02918	0.0003	significant
BC	90.25	1	90.25	0.478871	0.5112	non-significant
Residual	1319.25	7	188.4643			
Lack of Fit	1319.25	3	439.75			
Pure Error	0	4	0			
Cor Total	157747.8	16				

Std. Dev.	13.7282	R-Squared	0.9916
Mean	184.8824	Adjusted R-Squared	0.9809
C.V.	7.4254	Predicted R-Squared	0.8662
PRESS	21108	Adequate Precision	35.2002

The regression model generated by the software shown in Eq. (1) is significant and represents the closest relationship between the factors and the experimental values (Table 10). The model adequately captured 99.16% (R^2 = 0.9916) variationsin the predictionof the number of nose masks. Meanwhile, following the rule that values of Prob > F less than 0.05 are significant, model terms A, B, C, A^2, B^2, C^2, AB, and AC are significant except BC with Prob > F of 0.5112.The model's predicted R^2 value of 0.8662 agrees reasonably with the adjusted R^2 value of 0.9809. Also, its adequate precision value of 35.200 is greater than 4 the desirable noise ratio. From the test of significant effect in Table 11, the week of the study had the highest effect (P< 0.0001) onthe wearing of nose masks, followed by room temperature (P< 0.0004) then the period of the experiment (P<0.0011). Among the interaction effect, week of study and temperature had the highest effect followed by temperature and duration of practicals, the interaction between the duration of practical and week of the study had a non-significant effect. The magnitude of the significant effect of the model variables captured by the coefficient estimate (Table.12) or the regression coefficients indicates that week of study with a coefficient of -107.125 had the highest negative influence onthe wearing of nose masks than -30.5 and -25.875 of temperature and duration of practical respectively. It implies that as the week of study increased from week 3 to week 5, the number of students wearing nose marks reduced likewise across the duration of practical and temperature, respectively.

Table 12: Coefficient of estimating the quadratic model variables for the nose masked

Factor	Coefficient estimate	Df.	standard error	95% CI Low	95% CI High	VIF
Intercept	154	1	6.139451	139.4825	168.5175	
A-Temp	-30.5	1	4.853662	-41.9771	-19.0229	1
B-Tim	-25.875	1	4.853662	-37.3521	-14.3979	1
C-weeks	-107.125	1	4.853662	-118.602	-95.6479	1
A^2	17.875	1	6.690311	2.054927	33.69507	1.0059
B^2	-42.375	1	6.690311	-58.1951	-26.5549	1.0059
C^2	90.125	1	6.690311	74.30493	105.9451	1.0059
AB	21.5	1	6.864115	5.268948	37.73105	1
AC	44.5	1	6.864115	28.26895	60.73105	1
BC	4.75	1	6.864115	-11.4811	20.98105	1

The relationship between the actual and predicted number of students wearing nose masks is demonstrated graphically in Figure 1and with a linear equation as Eq. (2).

$$Y_{Pm} = X_{Am} + 0.0034 \ (R^2 = 0.9914) \qquad (2)$$

Where:Y_{Pm} = predicted number of the nose mask

X_{Am}= actual number of the nose mask

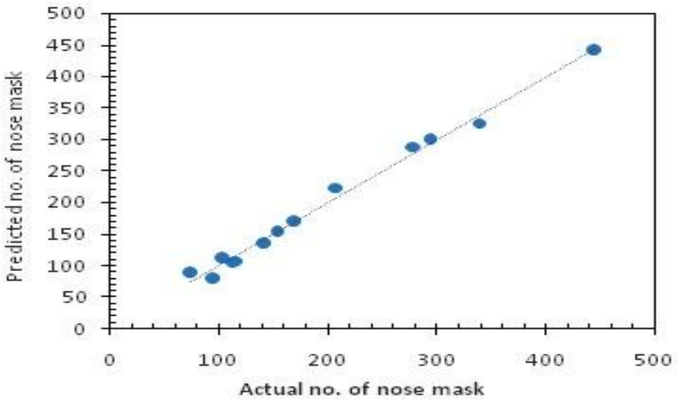

Fig. 1: Plot of predicted versus the actual number of nose masks

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Graphical representation of the number of students with nose masks at the interaction of room temperature, week of study and duration of practical (Fig.2) indicate a downward trend in nose masking across the interaction from week 3 to week 5. There were more students with nose masks in Week 3, then in Weeks 4 and 5 across the interactions between the duration of practical and room temperatures (Fig. 2).The number of nose masks dropped by 46.47% in week 3 (Fig. 2), 57.97% in week 4 and 77.30% in week 5. It dropped by 64.20% from week 3 to week 4, and 63.22% from week 4 to week 5.

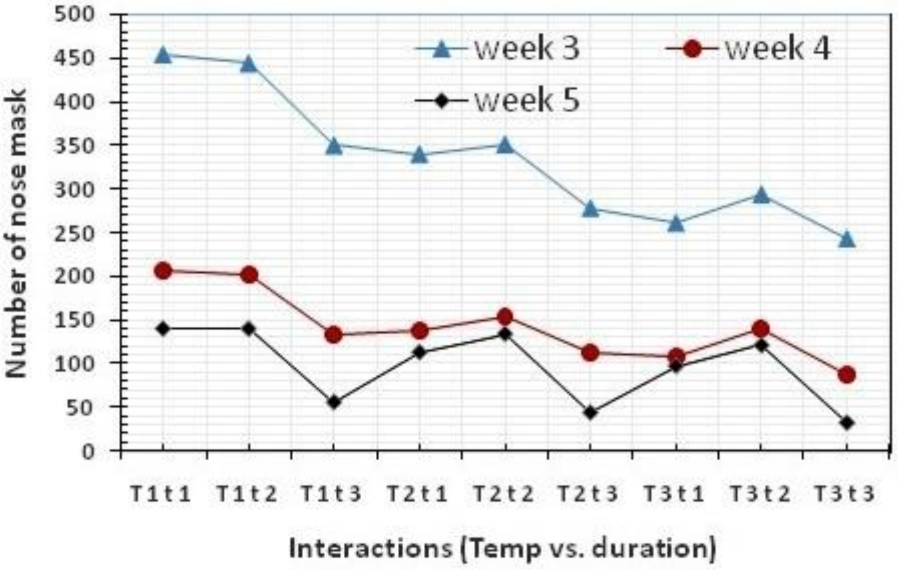

Fig 2: Effect of week of study across factors interactions on the number of Students wearing nose masks during practical class

Volume of water used for hand washing

The volume of water, V_w used for hand washing (experimental values) is shown in Table 10. The analysis of the relationship of the variable was represented in the regression model expressed by Eq. (3). The regression model was afterwards used to predict the volume of water placed side-by-side with the experimental values in Table 10for comparison. The analysis of the variance of the model variables is shown in Table 13.

$$V_w = 66 + 15.25A + 7.13B + 3.13C - 17.25A^2 - 0.5B^2 + 11C^2 + 5.75AC + 5.5BC \; [R^2 = 0.9973] \quad (3)$$

Table 13: The analysis of variance of the model variablesfor hand washing

Source	Sum of Squares	Df	Mean Square	F-value	Prob > F	Definition
Model	4296.221	9	477.3578	41.639	< 0.0001	Significant
A	1860.5	1	1860.5	162.287	< 0.0001	Significant
B	406.125	1	406.125	35.425	0.0006	Significant
C	78.125	1	78.125	6.815	0.0349	Significant
A^2	1252.895	1	1252.895	109.287	< 0.0001	Significant
B^2	1.053	1	1.053	0.092	0.7707	Non-significant
C^2	509.474	1	509.474	44.440	0.0003	Significant
AB	12.25	1	12.25	1.069	0.3357	Non-significant
AC	132.25	1	132.25	11.536	0.0115	Significant
BC	121	1	121	10.555		Significant

Residual	80.25	7	11.46429			
Lack of Fit	80.25	3	26.75			
Pure Error	0	4	0			
Cor Total	4376.471	16				

Std. Dev.	3.385895	R-Squared	0.981663
Mean	62.82353	Adjusted R-Squared	0.958088
C.V.	5.389533	Predicted R-Squared	0.706613
PRESS	1284	Adequate Precision	26.23357

The model is significant with an F-value of 41.64 and the model terms with P > F less than 0.0500 such as A, B, C, A^2, C^2, AC, and BC are significant. Its large coefficient of determination (R^2 = 0.9817) implies that it captured about 98.17% variations in the test. The above-stated characteristics of the model in addition to the close values between the Predicted and Adjusted R-Squares as well as high adequate precision (26.23) indicative of adequate (above 4 noise ratio) noise signal, implies that the generated regression model is adequate and can be used to navigate the design space.

From Table 13, the highest influence to hand washing came from ambient temperature ($P<0.001$) followed by the duration of practical ($P< 0.006$), then a week of study ($P< 0.0349$). The interaction between ambient temperature and week of study ($P<0.0115$) prompted more hand washing than the interaction between the duration of the practical and week of study ($P<0.0141$). Another observation was that the interactions promoted hand washing more than the week of study. From Table 14, the coefficient estimate of temperature was 15.25 higher than (7.125), (3.125) and 5.75 for the duration of practical, week of study and temperature and week of study interactions, respectively.

Table 14: Coefficient of the estimate of the quadratic model variables for hand washing

Factor	Coefficient estimate	Df	Standard Error	95% CI Low	95% CI High	VIF
Intercept	66	1	1.5142	62.4194	69.5806	
A-Temp	15.25	1	1.1971	12.4193	18.0807	1
B-Tim	7.125	1	1.1971	4.2943	9.9557	1
C-weeks	3.125	1	1.1971	0.2943	5.9557	1
A^2	-17.25	1	1.6501	-21.1518	-13.3482	1.0059
B^2	-0.5	1	1.6501	-4.4018	3.4018	1.0059
C^2	11	1	1.6501	7.0982	14.9018	1.0059
AB	-1.75	1	1.6929	-5.7532	2.2532	1
AC	5.75	1	1.6929	1.7468	9.7532	1
BC	5.5	1	1.6929	1.4968	9.5032	1

The effect of product models such as temperature and interaction between temperature and duration of practical were inhibitors to hand washing, however,that of the interaction was not significant. The actual and the predicted volumes of sanitizer plotted in Fig. 3 show there was a very minimal variance between the two values, hence the linear model captured wide variation (R^2 = 0.9815).

$$Y_{PV} = 1X_{AV} + 0.0035 \qquad (R^2 = 0.9815)$$

Y_{PV} = predicted volume of hand sanitizer used (cm^3)
X_{AV} = actual volume of hand sanitiser (cm^3)

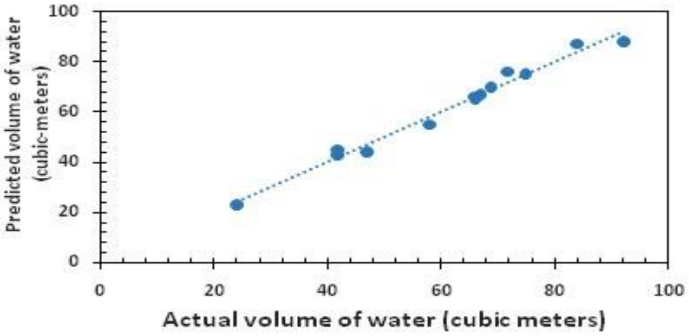

Fig. 3: Predicted against the actual volume of water for washing

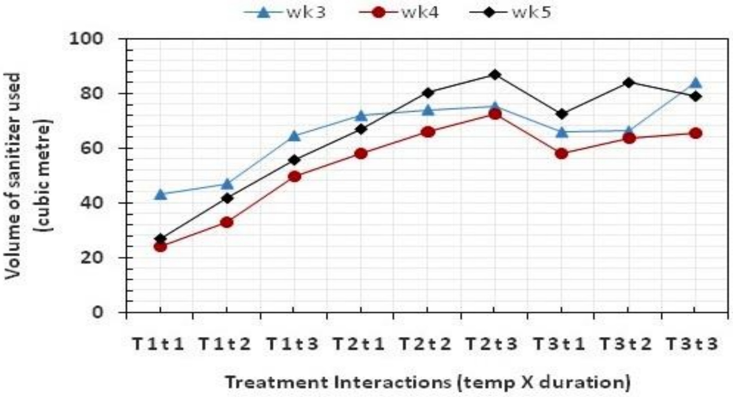

Fig. 4: Effect of the week of study across factors interactions on the volume of water used during students' practical class

Fig. 4 illustrates the interaction effects of the volume of sanitizer used for hand washing during the practical sessions and room temperature across the week of study. There is an increase in hand washing hygiene with the week of study as temperature and duration of practical increase.

From Fig. 4, in week 3, the volume of water used rose by 48.59%; it was 62.88 and 65.65% in weeks 4 and 5, respectively. From week 3 to week 4, it dropped by 28.06% and rose from week 4 to week 5 by 15.95%.

DISCUSSION

Students of tertiary institutions are required to comply with safety guidelines which include nose masking and regular hand washing to curb the spread of Covid-19. The compliance to these directives was subjected to practice class with the engineering students of Imo State Polytechnic Umuagwo. The influence of workshop temperature, duration of practical class and week of the study were tested on the student's compliance with these safety guidelines. From the socio-demographic characteristics, above 69.93% of the students are adults and could independently express their opinion without coercion. There were more males than females and more single than married with 84.64% of the students residing off-campus. Though the students came from different locations to school, their KAP evaluation of Covid-19 based on the study categorization was "good". These findings are in tandem with the reports of [1] and [12] on the KAP of students in Japan and China, respectively. There was no anxiety or fear by the students of being infested due to their "good" level of compliance with preventive guidelines. The KAP level of the students was determined in the first two weeks of school resumption which formed the background for the assessment of their compliance with nose masking and hand washing during practical classes.

The relationships between the independent variables and the dependent variables (nose masking and hand washing hygiene) generated regression models. Using significant difference and coefficient values of the regression model terms, the influence of the factors/interactions on the responses was defined. The model term with Prob>F value closest to zero (<0.0001) and with the highest coefficients (positive or negative) magnitude in the model equations has the highest impact on the response. The higher the coefficient of a significant model, term the higher the impact (negative or positive) on nose masking or hand washing hygiene. From the findings, the week of the study had an overwhelmingly negative influence on nose masking than workshop temperature and duration of the practical class. It was the predominant factor inthe violation of nose maskingguidelines. On the other hand, the three factors and their interactions also had an impact on handwashing hygiene. The most impactful influence on hand washing was workshop temperature.

CONCLUSION

The study was designed to achieve two objectives: first, to evaluate the KAP of engineering students in Imo State Polytechnic towards Covid-19; the second was the evaluation of compliance to WHO stipulated safety guidelines of nose masking and regular hand washing during practical class. The KAP conducted showed that 68.88%, 71.38%, and 60.63% of the students have 'good' KAP toward Covid-19. Between weeks 3 and 4, students that complied with nose masking dropped by 64.20% whereas the volume of water increased by 28.06%. Between weeks 4 and 5 nose masking dropped by 63.22%, while the volume of water for hand washing rose by 15.95. However, within week 3, the number of students that wore nose masks dropped by 46.47% whereas the volume of water used for hand washing rose by 48.59%. In week 4, the number of students with nose masks dropped by 57.97% but the volume of water rose by 62.88%. In week 5, nose make dropped by 77.30% but the volume of water increased by 65.66%.

Generally, the number of students with nose masks reduced as the week of study increased from week 3 to week 5; and as the workshop temperature rises across the three temperature levels of 23–25, 26-28 and 29-31^{o}C, respectively observed at every 20 minutes interval in a one-hour practical class. The week of the study had the highest influence on nose masking, followed by workshop temperature, and then the duration of the practical. Workshop temperature had the highest impact on hand washing hygiene than the duration of practical class while the week of the study had the least. The study showed that students' compliance with nose masking and hand washing hygiene during practical largely depended on external factors of workshop temperature, duration of practical, and duration of the semester. Nose masking reduced as the temperature of the workshop increased while an increase in hand washing was an adaptation to enhance the cooling of the body. The adaptation of conducting practical classes in the early hours of the morning, possibly between 8:00 am and 10:00 am when the prevailing temperature of the workshop is in the range of 23-28^{o}C will be the panacea to violation of Covid-19 safety guidelines.

The findings of this study will help develop prediction models of disease infectious transmission amongst tertiary engineering students. It can be informative in policy formulations and modulations of safety guidelines by health regulatory bodies toward curtailing the spread of Covid-19. The tertiary institutions will find it helpful in course allocation and timetable development within a semester. It is also insightful in the identification of the most vulnerable among students. Further studies may consider testing the models developed in this study on students outside engineering faculty and amongst customers in malls as the variables considered in this study are relatable to real-life shopping activities in malls and supermarkets.

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